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The Imputed Effect of the 2018 Tariffs on US Factor Shares

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The discretionary 2018 increase in the average tariff from 2% to 12% will have broad effects across the US economy reflected in the present predicted factor shares of capital, labor, skilled labor, and energy input. Error correction estimates of a Linear Almost Ideal Demand System introduce the price of import competing goods as a proxy for the average tariff in annual 1983-2018 data. The historically large tariff increase will boost the rising capital share of income while the declining labor share accelerates and the rising skilled labor share reverses. Capital is the only winner due to the increased tariffs.

Keywords: import tariffs; factor shares; skilled labor

JEL Classifications: F13; F14; F17; J30; Q43

The Presidential discretion increasing the average US import tariff from 2% to 12% in 2018 will have long term effects across the economy. This paper predicts the adjustments in factor shares of capital, labor, skilled labor, and energy input to this historically large increase. Including energy Btu input improves error correction estimates of a Linear Almost Ideal Demand System LAIDS of Deaton and Muellbauer (1979) in the annual 1983-2018 data. The underlying translog cost function includes interaction of the average tariff with factor prices in the factor proportions model.

The average tariff steadily declines with little variation over the sample due to the General Agreement on Tariffs and Trade (GATT). The import price index available since 1983 is included with the average tariff to derive the price of import competing goods. The imputed tariff assumes all variation in the price of import competing goods is due to tariffs. While the

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tariff itself has no effects, the imputed tariff has significant effects in the factor share estimates. Thompson and Thompson (2021, 2023) find imputed tariffs lower the skilled wage with no effect on the unskilled wage in estimates of reduced form equations based on factor proportions models.

Separating skilled labor with a college degree is motivated by the rising wage gap and the opposite trends of the two labor shares over the sample. Energy input with its generally falling trend reveals an upward trend in the capital share. Energy input utilizes capital and effectively captures technological progress as developed in Thompson (2014, 2019) and Copeland and Thompson (2021, 2022).

LAIDS estimates are familiar in the derivation of cross price elasticities of demand. Examples involving food products include Blanciforti and Green (1983), Karagiannis, Katranidis, and Velentzas (2000), Taljaard, Alemu, and van Schalkwyk (2004), and Gallet (2010). Tourism demand studies include Syriopoulos and Sinclair (1993), Li, Song, and Witt (2004), and Yamaura and Thompson (2015). On the supply side, factor price elasticities are estimated in Chambers and Pope (1994), Hilmer and Holt (1999), and Thompson (2013).

Large tariff increases are a recurring theme in US history starting with the levies by England on the colonies that led to the Revolutionary War and the constitutional ban on export tariffs. The Tariff of 1789 introduced a uniform 5% import tariff to fund the fledgling navy. Tariffs providing the main source of tax revenue rose to 40% before the jump to 60% in 1828 with the Tariff of Abominations. South Carolina refused to collect the tariff leading to the Nullification Crisis and a slow decline to 15%. The Morill Tariff of 1861 raised the average to 45% leading seven states to secede. Ater the Civil War tariffs remained close to 25% before dropping to 15% in 1913 with the 16th Amendment income tax. After World War I tariffs fell to 6% before creeping back to 15% by the end of the 1920s. The Smoot-Harley Tariff of 1930 raised the average to 30% worsening the Great Depression. After World War II the average tariff gradually fell under GATT from 10% to 2%.

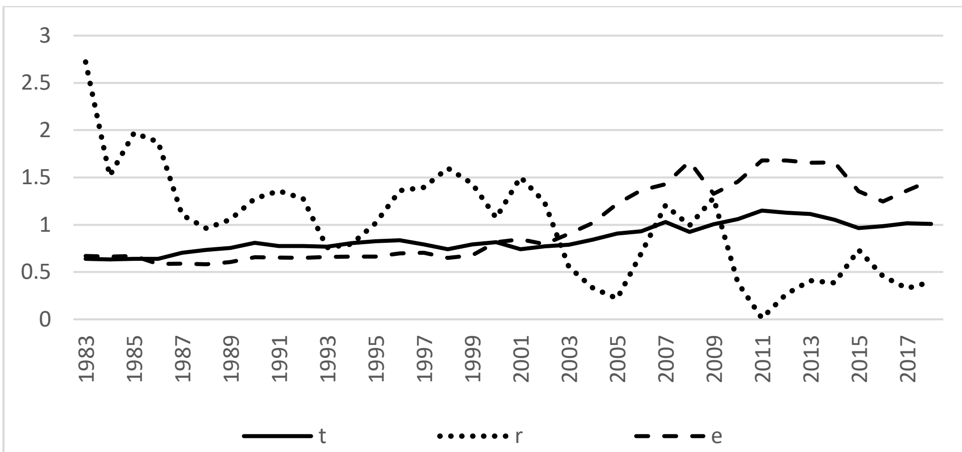
Several studies examine the detailed effects of the 2018 tariff increase in computable general equilibrium CGE models including the large industrial effects predicted effects in Li, Balisteri, and Zhang (2020). The impacts on industrial prices and deadweight losses are sizeable in Amiti, Redding, and Weinstein (2023). The present predicted adjustments in factor shares reflect these underlying adjustments in the general equilibrium.

Section 1 describes the present time series and the derivation of the imputed tariff. Section 2 develops the LAIDS factor share system and reports preliminary double difference estimates. Section 3 presents the cointegrating equation in differences and the error correction estimates. The Conclusion includes a discussion of policy implications.

1 Data and stationarity analysis

Figure 1 shows the capital return r as the nominal interest rate minus the inflation rate with an overall slow decline consistent with neoclassical growth theory. Macroeconomic data are from the Bureau of Economic Analysis BEA (2020). The average energy Btu price index e in Figure 1 from the Energy Information Agency EIA (2020) has a slight upward trend before the increase around 2000 with a doubling of the price of crude oil. After 2008 the energy price stabilizes due to increased oil and gas production in North America.

Figure 1. Imputed average tariff *t*, capital return r, and energy price *e*



The average tariff $\tau = TR/M$ derived from tariff revenue $TR = \tau M$ reported by the White House Budget Office (2020) and import spending M declines steadily at a decreasing rate from 2.7% in 1983 to about 2% by 2006 where it stays until 2018. This slow decline provides no basis to estimate effects of the large 2018 increase. The imputed tariff $t = (1 + \tau)p_M$ in Figure 1 includes the freight on board FOB import price index p_M from the Federal Reserve Economic Data FRED (2020). The steady upward trend in p_M has increased variation after 2000 due in large part to the price of energy imports. The high variation in the imputed tariff t serves as a proxy to predict adjustments large 2018 tariff increase.

Figure 2 plots factor shares of income with the skilled labor share θ_S rising from 16.2% to 25.1% (standard deviation 2.5%) as the labor share θ_L falls from 31.6% to 19.5% (4.0%). The skilled wage w_S rises faster with more variation than the wage w_L in the Census (2019) data. The energy share θ_E ranges between 5.5% and 11.5% (1.4%) with a slight downward trend that reverses around 2000. The slowly rising residual capital share θ_K has mean 45.6% (2.3%). The more familiar residual capital share including payment to energy meanders between 50% and 57% with mean 53.2% (2.1%). The share of total labor ranges from 50% to 43% without an apparent trend and mean 46.7% (0.03%).

Wages and output are converted to natural logs making their first differences percentage changes. The factor shares, capital return, energy price index, and imputed tariff are treated as simple differences. All variables are nonstationary in first differences with high residual correlation in unreported autoregressive analysis.

Figure 2. Factor Shares θ_i

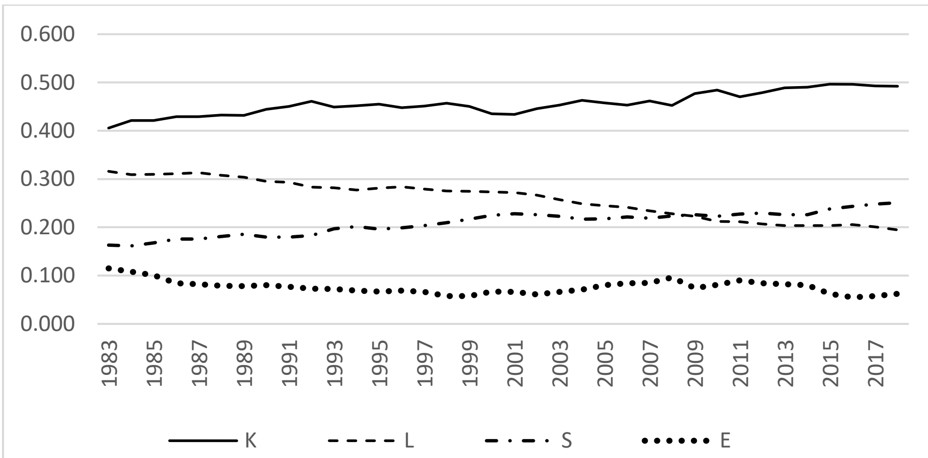


Table 1 reports stationary double differences with Dickey and Fuller (1979) DF tests $\Delta^2 y_t = \alpha_1 + \alpha_2 \Delta y_{t-1} + \eta_t$ rejecting the null hypothesis $\alpha_2 \neq 0$. The DW column reports a lack of residual correlation for the DF residuals η_t in Durbin-Watson (1950) tests. Autoregressive conditional heteroskedastic ARCH tests $\eta_t^2 = \alpha + \delta\eta_{t-1}^2 + \zeta_t$ fail to reject the null hypothesis of constant variance $\delta = 0$ except for the skilled wage. The imputed tariff t has some persistence in variance. As an estimate of variance, the intercept α in ARCH tests is highest for the two wages. The stationary double differences lead to reliable robust error correction estimates.

Table 1. Stationarity properties

	DF t-stat	DW 2(1-ρ)	ARCH t-stat	ARCH σ^2
$\Delta^2\theta_L$	-2.86	1.99	0.04	2.56
$\Delta^2\theta_S$	-4.51	2.00	-0.83	3.40
$\Delta^2\theta_E$	-5.04	1.90	0.16	2.93
$\Delta^2\theta_K$	-6.83	1.98	-0.62	3.59
$\Delta^2 lnw_L$	-4.56	2.02	-0.44	3.95
$\Delta^2 lnw_S$	-4.77	2.00	-1.87	4.32
$\Delta^2 lne$	-5.54	1.84	0.71	2.45
$\Delta^2 r$	-6.66	2.01	0.18	3.13
$\Delta^2 lny$	-5.42	1.83	-0.41	3.43
$\Delta^2 t$	-5.90	1.91	1.30	2.74

2 The LAIDS model and preliminary double difference estimates

The LAIDS model of Deaton and Muellbauer (1979) on the production side leads to factor price elasticities based on the underlying translog cost function. The assumption is cost minimization with factors paid marginal products. The present modification includes interaction between the imputed tariff t and factor prices w_i with c representing total cost,

$$\ln c = \Sigma_i\alpha_i \ln w_i + ½\Sigma_i\Sigma_j\beta_{ij}\ln w_i \ln w_j + \Sigma_i\gamma_k \ln y \ln w_i + \Sigma_i\delta_i t w_i. \qquad (1)$$

Real output $y = Y/\omega$ is nominal GDP deflated by the almost ideal price index $\ln\omega = a_0 + \Sigma_i\alpha_i \ln w_i + ½\Sigma_i\Sigma_j\gamma_{ij}\ln w_i \ln w_j$. The share of factor k is the first derivative of (1) with respect to $\ln w_k$,

$$\theta_k = \alpha_k + \Sigma_i\beta_{ki}\ln w_i + \gamma_k \ln y + \delta_k t + \varepsilon_i, \qquad (2)$$

where $\theta_k = \partial \ln c/\partial \ln w_k = v_k w_k/c$ and v_k is the factor input level due to Shephard's lemma $\partial c/\partial w_k = v_k$. Factor prices w_{i-1} are lagged in the estimates to lessen endogeneity as suggested by Eales and Unnevehr (1988). The estimates are based on the simpler Stone (1954) index $\ln P = \Sigma_i\beta_i \ln w_i$ given the colinear factor prices. The assumption is that the price index P is exogenous to factor shares. The coefficients γ_k prove insignificant consistent with homothetic production.

The estimated factor share system is symmetric given Young's theorem under the constraint,

$$\beta_{ki} = \beta_{ik}. \qquad (3)$$

Factor shares are also homogenous of degree zero in factor prices with the constraint,

$$\Sigma_i\beta_{ki} = 0 \qquad (4)$$

The capital share equation is derived from estimates of the other three. A unit sum of factor shares is ensured by the sufficient conditions,

$$\Sigma_i\alpha_i = 1 \text{ and } \Sigma_k\gamma_k = 0. \qquad (5)$$

The unit sum of factor shares implies a singular residual variance-covariance matrix as developed in Sulgham and Zapata (2006). The seemingly unrelated regression SUR program *sureg* of Stata provides the present estimates.

Table 2 shows the preliminary double difference estimates of (2) through (5) without energy input. Stationary double differences are reflected by residual correlations, mild for $\Delta^2\theta_L$ and absent for $\Delta^2\theta_K$. The insignificant constants α_k imply no unexplained trends in the differences of factor shares. A higher wage for either labor group raises its factor share and lowers the other. The capital return r has no effects on factor shares. The imputed tariff t has marginally insignificant effects, negative on the two labor shares and positive on the capital share.

Table 2. Double differences without energy input

Δ^2	θ_L	θ_S	Derived θ_k
$\ln w_L$	0.097*** (0.012)	-0.103*** (0.012)	0.006 (0.004)
$\ln w_S$	-0.103*** (0.012)	0.103*** (0.012)	-0.001 (0.004)
r	0.006 (0.004)	-0.005 (0.004)	-0.001 (0.007)
lny	0.014 (0.010)	-0.002 (0.008)	-0.012 (0.016)
t	-0.013 (0.012)	-0.012 (0.010)	0.025 (0.020)
α	-0.0002 (0.0008)	-0.0001 (0.0007)	
DW ARCH σ^2 R^2	2.85^ 0.37 3.02 -0.15	2.40 0.73 3.10 0.58	

***1%

Table 3 reports preliminary double difference estimates. Including energy input is highly supported with the energy share θ_E sensitive to every variable and price e affecting every factor share. The effects of e on the two labor shares are negative but positive on the capital share.

The imputed tariff t has a positive effect on θ_K and a negative effect on θ_S. The effect on θ_L remains negative but insignificant as in Table 2 similar to the effect on θ_E. To gauge the impact of the 2018 tariff increase $\Delta\tau = 0.10$, the import price index t increases from 1.008 to 1.108 leading to $\Delta t = 0.099$. Table 2 then leads to the predicted factor share adjustments,

$$\Delta\theta_K = 0.047 \text{ x } 0.099 = 0.0047$$

$$\Delta\theta_L = -0.0020$$

$$\Delta\theta_S = -0.0018$$

$$\Delta\theta_E = -0.0008.$$

Table 3. Double differences with energy input

Δ^2	θ_L	θ_S	θ_E	Derivedθ_K
$\ln w_L$	0.112*** (0.013)	-0.081*** (0.012)	-0.037*** (0.004)	0.005 (0.005)
$\ln w_S$	-0.081*** (0.012)	0.115*** (0.011)	-0.030*** (0.003)	-0.004 (0.004)
lne	-0.037*** (0.004)	-0.030*** (0.003)	0.060*** (0.004)	0.007** (0.003)
r	0.005 (0.005)	-0.004 (0.004)	0.007** (0.003)	-0.007 (0.011)
lny	0.013 (0.011)	-0.007 (0.009)	0.016*** (0.006)	-0.022 (0.022)
t	-0.020 (0.013)	-0.018* (0.011)	-0.008 (0.007)	0.047* (0.026)
α	-0.0001 (0.009)	-0.00005 (0.0008)	0.0002 (0.0005)	
DW	2.47	2.28	2.12	
ARCH	-0.61	0.27	-0.31	
σ^2	3.24	3.01	3.17	
R^2	-0.47	0.49	0.95	

*10% **5% ***1%

These adjustments are summarized in the vector of factor shares starting at their 2018 levels,

$$\begin{pmatrix}\theta_L\\ \theta_S\\ \theta_E\\ \theta_K\end{pmatrix} = \begin{pmatrix}0.195\\ 0.251\\ 0.062\\ 0.492\end{pmatrix} \rightarrow \begin{pmatrix}0.193\\ 0.249\\ 0.061\\ 0.497\end{pmatrix}$$

3 Error correction estimates of the factor share system

Error correction estimates in double differences include the residual ε from the cointegrating estimates in differences. The estimated error correction system,

$$\Delta^2\theta_k = \alpha_k + \Sigma_i\beta_{ik}\Delta^2\ln w_{i-1} + \gamma_k\Delta^2\ln y + \delta_k\Delta^2 t + \eta_k\varepsilon + e, \qquad (6)$$

includes coefficients η_k related to cointegration. The total effect is derived as the sum δ_k in (6) minus η_k times the coefficient of t in the cointegrating equation.

Tables 4 presents the cointegrating equation estimates without energy input, and Table 5 with energy input. The significant constant terms suggest unexplained trends in factor shares that disappear in the derived total effects. The negative Engle-Granger EG (1987) statistics provide evidence of cointegration. The estimates are reliable based on the lack of residual correlation in the DW coefficients and heteroskedasticity in the ARCH coefficients. Including energy input reveals its price e affects every factor share, and every variable affects θ_E. Energy input lowers the estimated variance σ^2 of the labor share residual in the ARCH statistic but raises it for skilled labor.

Coefficients in the difference equation estimates in Tables 4 and 5 differ from the double difference estimates in Tables 2 and 3. The capital return r lowers θ_S in Table 4 while the double difference effect is insignificant. The negative effect of t on θ_S disappears in Tables 4 and 5 as do the cross effects between energy and capital.

Table 4. Cointegrating equations in differences without energy input

Δ	θ_L	θ_S	Derived θ_K
$\ln w_L$	0.105*** (0.011)	-0.101*** (0.011)	-0.005 (0.004)
$\ln w_S$	-0.101*** (0.011)	0.110*** (0.011)	-0.010*** (0.003)
r	-0.005 (0.004)	-0.010*** (0.003)	0.014** (0.006)
lny	-0.011 (0.008)	-0.021*** (0.007)	0.032** (0.014)
t	-0.020 (0.013)	-0.016 (0.012)	0.036 (0.023)
α	-0.003*** (0.001)	0.003*** (0.001)	
DW ARCH σ^2 R^2 EG	2.09 -0.46 3.76 0.05 -1.04***	1.98 -0.46 3.71 0.62 -0.99***	

**5% ***1%

Tables 6 and 7 below report the error correction estimates of (5) based on the error correction residuals ε from Tables 4 and 5. The robust error correction effects provide further evidence of cointegration. The insignificant constant terms α indicate lack of unexplained trends in factor shares. All coefficients involving energy prove significant. Energy price e has negative effects on both labor shares, a small positive effect on the capital share, and a strong positive own effect. Including energy input reveals stronger negative effects of t on the two labor shares.

Table 5. Cointegrating equations in differences with energy input

Δ	θ_L	θ_S	θ_E	Derived θ_K
lnw_L	0.115*** (0.011)	-0.083*** (0.011)	-0.034*** (0.003)	0.002 (0.005)
lnw_S	-0.083*** (0.011)	0.121*** (0.011)	-0.032*** (0.003)	-0.007 (0.004)
e	-0.034*** (0.003)	-0.032*** (0.003)	0.064*** (0.003)	0.002 (0.003)
r	0.002 (0.005)	-0.007 (0.004)	0.002 (0.003)	0.002 (0.011)
lny	0.006 (0.010)	-0.013* (0.009)	0.005 (0.006)	0.002 (0.023)
t	-0.010 (0.013)	-0.009 (0.012)	-0.007 (0.008)	0.026 (0.029)
α	-0.004*** (0.001)	0.003*** (0.001)	-0.001** (0.0004)	
DW	2.12	1.78	1.77	
ARCH	0.96	-1.00	0.09	
σ^2	2.96	4.19	0.33	
R^2	-0.08	0.49	0.94	
EG	-1.06***	-0.89***	-0.89***	

*10% **5% ***1%

Table 6. Error correction estimates without energy input

Δ^2	θ_L	θ_S	Derived θ_K
lnw_L	0.110*** (0.009)	-0.104*** (0.009)	-0.007* (0.003)
lnw_S	-0.104*** (0.009)	0.112*** (0.008)	-0.008*** (0.003)
r	-0.007* (0.003)	-0.008*** (0.003)	0.015** (0.006)
lny	-0.015* (0.008)	-0.019*** (0.007)	0.034*** (0.013)
t	-0.017* (0.009)	-0.013* (0.008)	0.030** (0.015)
ε	-1.18*** (0.157)	-0.89*** (0.156)	
α	-0.0002 (0.0006)	-0.00004 (0.0005)	
DW	2.25	2.14	
ARCH	0.11	0.26	
σ^2	3.20	3.31	
R^2	0.45	0.79	

*10% **5% ***1%

Table 7. Error correction estimates with energy input

Δ^2	θ_L	θ_S	θ_E	Derived θ_K
$\ln w_L$	0.128*** (0.010)	-0.085*** (0.009)	-0.039*** (0.003)	-0.004 (0.004)
$\ln w_S$	-0.085*** (0.009)	0.124*** (0.008)	-0.028*** (0.002)	-0.011*** (0.003)
e	-0.039*** (0.003)	-0.028*** (0.002)	0.061*** (0.002)	0.005** (0.003)
r	-0.004 (0.004)	-0.011*** (0.003)	0.005** (0.003)	0.011 (0.008)
lny	-0.009 (0.008)	-0.023*** (0.007)	0.012** (0.005)	0.020 (0.017)
t	-0.027*** (0.009)	-0.020*** (0.007)	-0.011** (0.005)	0.058*** (0.019)
ε	-1.191*** (0.145)	-1.037*** (0.132)	-0.939*** (0.167)	
α	-0.0002 (0.0006)	-0.0001 (0.0005)	0.0001 (0.0004)	
DW	1.97	1.69	1.89	
ARCH	0.44	0.78	-0.92	
σ^2	3.17	3.06	3.36	
R^2	0.34	0.75	0.97	

**5% ***1%

Figure 3 shows the improved properties for residuals of the labor share $\Delta^2\theta_L$ with energy input. The mean of the residual falls from -6.06E-10 to 6.57E-20 and residual correlation from -0.75 to 0.15. Including energy lowers the estimated variance of the residual in the constant term of ARCH regressions from 3.20 to 3.17 and leads to similar weaker improvements in the $\Delta^2\theta_S$ estimate.

Tables 8 and 9 report the derived error correction effects with standard errors from error propagation. The energy price e raises its own share, lowers both labor shares, and has a small positive effect on the capital share. Including energy eliminates the negative effect of the wage w_L on θ_K revealing the negative effect on θ_E. The capital return r loses its effect on θ_L, has a weaker own effect on θ_K, and weakly raises θ_E.

Figure 3. EC residuals in the θ_L estimate

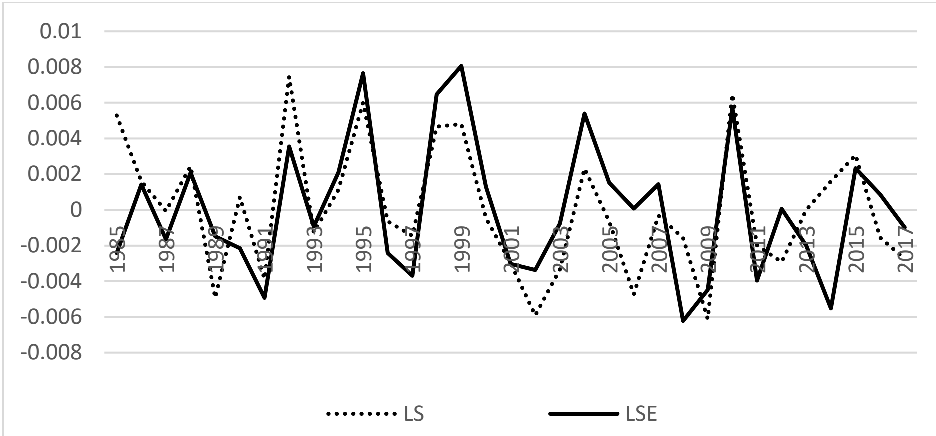


Table 8. Derived total effects without energy input

	θ_L	θ_S	θ_K
lnw_L	0.234^{***} (0.023)	-0.193^{***} (0.020)	-0.012^{***} (0.006)
lnw_S	-0.222^{***} (0.022)	0.210^{***} (0.022)	-0.017^{***} (0.004)
r	-0.012^{**} (0.006)	-0.017^{***} (0.004)	0.029^{***} (0.007)
lny	-0.028^{**} (0.013)	-0.038^{***} (0.010)	0.066^{***} (0.016)
t	-0.041^{***} (0.018)	-0.028^{**} (0.013)	0.068^{***} (0.022)

Table 9. Derived total effects including energy input

	θ_L	θ_S	θ_E	θ_K
lnw_L	0.265^{***} (0.024)	-0.171^{***} (0.018)	-0.070^{***} (0.007)	-0.002 (0.007)
lnw_S	-0.184^{***} (0.020)	0.250^{***} (0.021)	-0.058^{***} (0.006)	-0.018^{***} (0.006)
e	-0.079^{***} (0.007)	-0.061^{***} (0.006)	0.121^{***} (0.011)	0.007^{**} (0.003)
r	-0.002 (0.007)	-0.018^{***} (0.006)	0.007^{*} (0.003)	0.013^{*} (0.010)
lny	-0.002 (0.015)	-0.037^{***} (0.012)	0.017^{***} (0.007)	0.056^{***} (0.020)
t	-0.039^{**} (0.018)	-0.029^{**} (0.015)	-0.017^{*} (0.010)	0.086^{***} (0.025)

The robust negative effects of t on the two labor shares are similar regardless of energy input. Including energy reveals a stronger positive effect of t on θ_K. The negative effect of t on θ_E is weaker than on the two labor shares.

Table 10 compares the double difference predictions in Table 3 with the error correction predictions in Table 9. The 2018 tariff raises θ_K lowering the other factor shares. The increase $\Delta t = 0.099$ in the import price index implies,

$$\Delta\theta_K = .077 \text{ x } 0.099 = 0.0076$$

$$\Delta\theta_L = -0.0038$$

$$\Delta\theta_S = -0.0029$$

$$\Delta\theta_E = -0.0010.$$

The resulting error correction factor share adjustments from their 2018 levels are then,

$$\begin{pmatrix} \theta_L \\ \theta_S \\ \theta_E \\ \theta_K \end{pmatrix} = \begin{pmatrix} 0.195 \\ 0.251 \\ 0.062 \\ 0.492 \end{pmatrix} \rightarrow \begin{pmatrix} 0.191 \\ 0.248 \\ 0.061 \\ 0.500 \end{pmatrix}. \quad (7)$$

Table 10. Predicted factor share adjustments

%	θ_L	θ_S	θ_E	θ_K
2018 levels	19.5	25.1	6.2	49.2
Double Differences	19.3	24.9	6.1	49.7
Error Correction	19.1	24.8	6.1	50.1

The 2018 tariff increase reinforces the downward trend in the labor share θ_L that started at 30.9% of national income in 1983 falling to 19.5% by 2018. This prediction flies in the face of the political claim that tariffs protect labor interests. The 2018 tariffs reverse the rising trend in the skilled labor share θ_S that climbed from 16.2% to 25.1% of national income over the sample. The energy share θ_E starting at 10.8% and falling to 6.2% by 2018 is predicted to decrease slightly.

The largest predicted effect of the 2018 tariffs is to bolster the rising capital share that starts at 42.1% of national income in 1983 and rises to 7.1% by 2018 before the additional 8% boost due to the tariffs. This prediction reinforces the point that tariffs should not be considered a tool for income redistribution. The increased demand for capital is due to factor price substitution as well as factor intensity across the four factors of production.

3 Conclusion

The historically large 2018 tariff increase is predicted to raise the capital share of income at the expense of labor, skilled labor, and energy inputs. The increase in the capital share of income will boost its upward trend since 1983. The downward trends in the labor share will accelerate as it will for energy input. The rising trend of the skilled labor share will reverse. The reduction in GDP due to the tariffs suggests capital could suffer lower income along with the other factors of production. These adjustments in factor shares reflect the core topic of the effect of tariffs on factor prices in trade theory summarized in Thompson (2016).

The political economy of Presidential discretion over tariffs should be mentioned. While Congress determines tariffs by law, the President can impose temporary tariffs based on national defense, unreasonable business practice, or damage from import competition. These vague laws dating from the 1960s should be clarified starting with the definition of temporary. The appeal to national defense raises the issue of which import competing industries do not qualify. Almost all business practices are considered unreasonable by the competition. Damage from import competition is half of the story of the gains from trade. The Supreme Court might consider the major question of whether Congress intended to give the President the discretionary power over the economy illustrated by the 2018 tariffs.

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